

Integrated Water Resources Management in the Lower Jordan Rift Valley

Sustainable Management of Available Water Resources with Innovative Technologies



Work package 6, Deliverable D 606

Knowledge Management System

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PREFACE

This report evolved from the work within the SMART-Project for Sustainable Management of Available Water Resources with Innovative Technologies in the Lower Jordan Valley (Wolf and Hötzl, 2011) funded by the German Federal Ministry for Education and Research (BMBF). Within this framework the herein presented work is founded on large parts on research conducted in the course of the PhD-Thesis:

Riepl D (2013): Knowledge-Based Decision Support for Integrated Water Resources Management with an application for Wadi Shueib, Jordan. *PhD-Thesis*, Karlsruher Institut für Technologie

Against this background, it is as much an input to a multi-lateral and interdisciplinary IWRM research initiative, as a general contribution to the domain of IWRM planning and decision support.

EXECUTIVE SUMMARY

The international water sector community strives to improve communication and understanding between actors in the IWRM domain, in order to ensure best-possible responses to the upcoming water resources challenges. In this regard, the presented work develops an approach to collaboratively manage planning and decision making knowledge on the basis of semantic web technologies.

Within the presented work, a conceptual structure and requirements were developed and formalized in an ontology prototype for IWRM planning and decision support knowledge sharing. The concept was implemented as semantic wiki application and opened to the research and stakeholder community of the SMART project. The platform demonstrates a potential to provide solutions for various critical knowledge management requirements. For example to help water sector experts to easily document and formalize their work in a semantic structure, invite colleagues and stakeholders to review and comment, consistently connect their work to previously undertaken studies, and share their insights and work processes with a wider audience over the internet. It is expected that future IWRM initiatives could benefit from comparable approaches, and valuable insights on the subject can be achieved from the pilot study in this thesis.

1 INTRODUCTION

1.1 Motivation and Objectives of IWRM Knowledge Management

The idea of Integrated Water Resources Management (IWRM) presumes a holistic approach in water resources modelling and the definition of transparent planning scenarios. In this regard, a comprehensive IWRM framework has to combine data and information from various different domains and sources, and at the same time produce readily usable information for decision making. In a productive and institutionalized environment, an IWRM analysis of this manner involves a highly collaborative process between sector experts, decision makers and local stakeholders.

In this respect, some discussion has already been progressing in recent years, about how to span the gap between scientific environmental modelling and respective political decision making (Acreman, 2005, Liu, et al., 2008). Most contributions on this topic agree on the urgent need to improve communication and transparency between science and policy. Regarding the multi-disciplinary nature of IWRM, it is also the information flow between the participating experts that poses challenges (Riepl, 2013). Thus, the development of a comprehensive and interdisciplinary water resources knowledge base is perceived as fundamental to integrated water resources assessments and consequent planning and decision making (GWP, 2000).

It is also recognised that contemporary knowledge management techniques can contribute to improving the performance and effectiveness of both capacity development (Luijendijk and Lincklaen Arriëns, 2007) and knowledge sharing (Giupponi and Sgobbi, 2008) in the water sector, provided that there is a basic capacity in place to coordinate this approach. To handle this necessity, most IWRM projects carried out during the last years already had knowledge sharing initiatives on their agenda. The requirement for such a knowledge framework is tackled in current IWRM approaches in several manners:

- (1) Applied projects and case studies share multi-thematic databases to enable data access, transfer and comparability between interdisciplinary modelling environments.
- (2) Joint projects implement internet platforms for building and distributing thematic bibliographies as information portals on IWRM related topics,
- (3) or focus on supporting Capacity Building Networks in the IWRM environment.

On the other hand, and although growing in other disciplines, the direct support of collaborative knowledge-building and sharing processes has been less prominent in water research. Several organizations have recently started such initiatives of which probably the most visible example is the UNDP-initiated WaterWiki (WaterWiki, 2012). But especially in the planning practice respective approaches are still lacking satisfactory consideration in state of the art approaches on IWRM-Decision-Support-Systems. Yet, the potential for a continuous online collaboration process appears evident as:

- (1) the IWRM planning process is meant to be highly collaborative per se,
- (2) the community of experts often is spatially and disciplinary distributed and
- (3) planning and decision-making has often to be immediately and cannot stall until an eventual knowledge transfer process has taken place at some point in the future.

Following these insights, the SMART research initiative has embarked on the realization of a knowledge management system for collaborative documentation and sharing of planning and decision making relevant knowledge for integrated water resources management in the Lower Jordan Valley. Within this scope, the possibilities of contemporary semantic web techniques were investigated and applied to implement a functional online platform that can be used for collaborative knowledge management by the participants and stakeholders of the SMART project, and which has a potential to be integrated into future IWRM initiatives. As such, the presented platform represents a part of the full decision support framework of SMART (Fig. 1). The latter including other components, as for example a central database, various expert models as well as dedicated modules for Multi-Criteria Decision Analysis and Optimization (Wolf and Hötzl, 2011).

This report delineates the conceptual design of the generic IWRM knowledge management model, as well as their subsequent implementation in the DROPEDIA platform on the basis of the Semantic Mediawiki-technology (Krötzsch, et al., 2006).

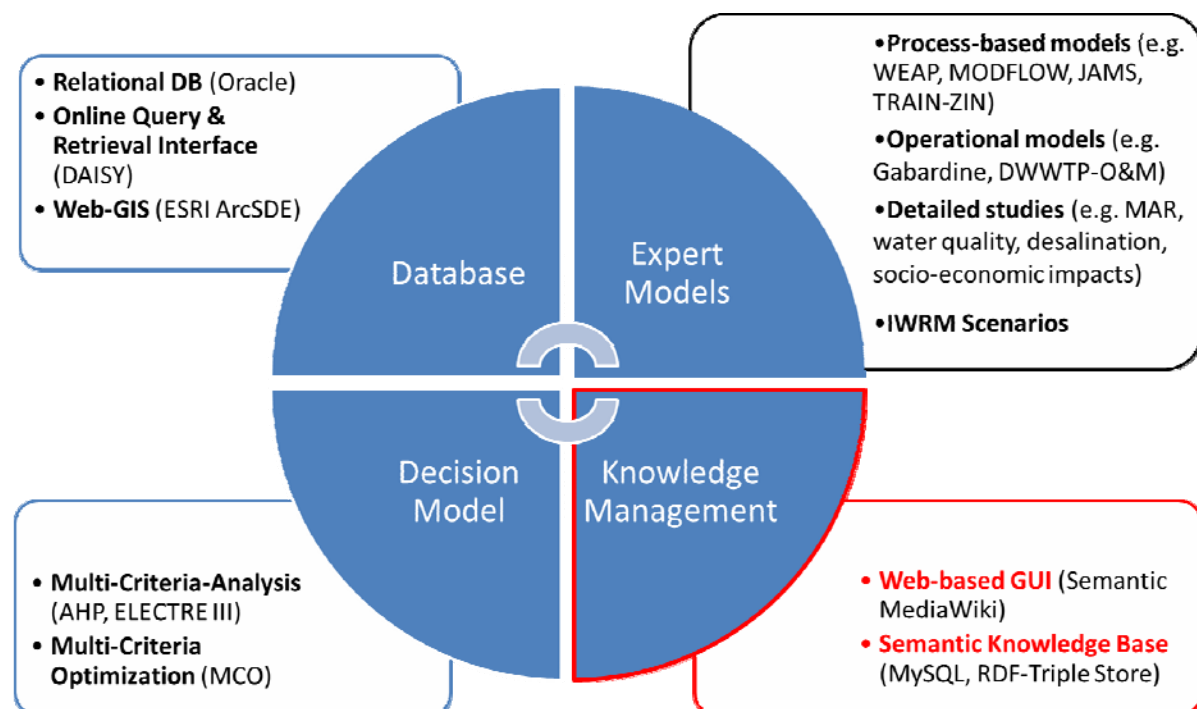


Fig. 1: Components of the SMART-Decision Support framework for Integrated Water Resources Management in the Lower Jordan Valley. Elements marked in red are discussed in this report (modified after Riepl (2013)).

1.2 Perception of Knowledge Management in the Jordan Valley Water Sector

Any knowledge management initiative stands and falls with the willingness to contribute of its addressed users. In order to assess the basic perception on the subject among water professionals associated to the study region, a set of questions was given to the attendees of a large SMART coordination meeting in 2011 (Wolf, et al., submitted). A total of 53 participants (38 % from Jordan, Palestine and Israel, 62 % from Germany), including scientists from the project consortium and associated stakeholders, filled out the anonymous questionnaire. Fig. 2a-d displays the outcomes specifically addressing knowledge management issues.

On a general level, a strong majority agrees that more publicly available information would increase the public acceptance of water policy, both on transboundary and local level (Fig. 2a). Transparency appears to be perceived as important facilitator in a political decision making that follows the national guidelines. However, in terms of current stakeholder participation processes, opinions are far more ambiguous. Especially on the local level, the majority is rather undecided whether stakeholder participation is sufficiently supported.

The participating experts generally responded positively (72 %) on the proposal of using a wiki based platform for support IWRM in the context of their work and on the time they were willing to invest into such an initiative (Fig. 2b). Again, transparency and public information appear as strongest incentives for contribution, followed by information retrieval and dissemination on a professional level (Fig. 2c).

Taken together, these opinions point towards a strong feeling for the need of improved communication and information between decision makers, water sector experts and the wider public, but at the same time water professionals are cautious about facilitating direct participation in decision processes (a possible flaw in the questions might be related to the unclear definition of 'stakeholder'). Thus, following this opinion poll would recommend a semi-open information and participation system.

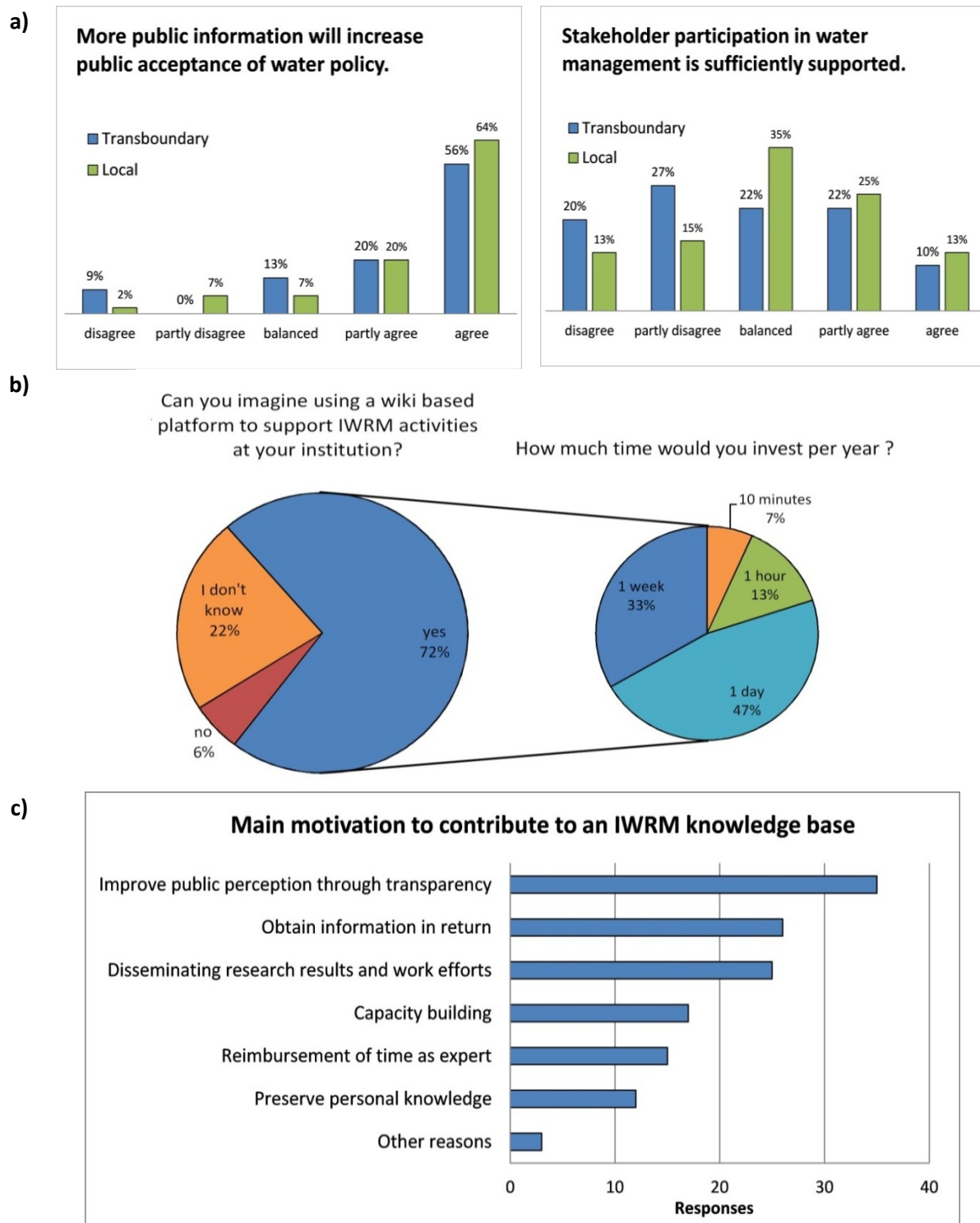


Fig. 2: Results from an expert opinion poll about transparency, participation and knowledge management in the Lower Jordan River Valley (Riepl, 2013).

1.3 Managing IWRM Knowledge

The term ‘knowledge management’ has become a popular buzzword throughout various disciplines, including the domains of water research and management. Yet, it often lacks unambiguous definition and formal distinction from matters of data and information management. Put in the broadest context, the subject of knowledge management can be summarized with the following characterization (Riepl, 2013):

Knowledge Management comprises the strategies and techniques that an organisation (or individual/enterprise/community) deliberately employs to create, gather, retain, organize, analyse, improve and share its knowledge in order to achieve its strategic objectives.

Given this definition it is important to note that Knowledge Management, while usually facilitated by technology, is not necessarily technology-bound. This highlights one major difference to the closely related field of Information Systems. And with the implicit diversity of the knowledge concept comes the impossibility of a single generic knowledge management strategy which could be facilitated by the use of one specific instrument. In this sense, it must be adapted to the given objectives, the given environment and the people that eventually are both: the providing and receiving end of the knowledge.

In IWRM the combination of physical system modelling with social, ecological and economic factors requires the integration of data and information from several different domains. The impacts of the planning scenarios have to be assessed from various perspectives and represented by an interdisciplinary set of indicators. Hereto, IWRM planners have to build on the pool of previous works, as well as on the cooperation with sector experts and stakeholders from various interest groups. Transferred to a productive and institutionalized environment, an IWRM analysis of this manner involves a highly collaborative process between such distributed knowledge sources.

Thus, it was found that, within the domain of IWRM planning and decision making, ‘knowledge in need of managing’ essentially relates to the necessary comprehensive system understanding and the assumptions that are used to drive planning and decision making within such systems. And **knowledge management for IWRM decision support therefore appears foremost as a means of facilitating the transportation and retrieval of system understanding between participants in the planning and decision process.**

For this purpose the SMART Decision Support framework focused on an enabling technology with strong collaborative functionalities: semantic wiki. Semantic wikis are very much what the name suggests, a combination of semantic web and wiki technology which will be briefly described in the next section.

1.4 Wikis and Semantic Wikis

Wikis (derived from the Hawaiian word for “quick”), and especially semantic wikis, can be considered as knowledge management instruments of the younger generation. Regarding their basic purpose as online collaboration tools wikis are often associated to the web 2.0 (the web of user generated content) development. Wikis enable online interaction and collaboration in the form of web pages which can be edited and structured with a simple mark-up language by anyone who has appropriate access and an internet browser.

Probably the most fundamental wiki feature is the free and welcome access of any interested user to edit wiki content. The latter is basically represented as **wiki-articles** (hypertext-pages dedicated to the description of a subject), but can also involve most media formats (documents, images, videos, etc.). Editing includes creating, changing, deleting and linking wiki articles in order to collaboratively evolve a knowledge network. The technological barrier is relatively low as users don't need any additional client software but their web browser, the edit mode is directly accessed from an article page and the wiki-markup language (“*wikitext*”) is fairly easy to learn. From there on, functionality between different wiki-engines vary greatly, as the term is applied to a diverse set of systems. The popular MediaWiki (MW, 2012) for example, which is also the wiki-engine used on the Wikipedia, records the complete content history, and any earlier version can be revoked which is as much a security as a documentation feature. Navigation is kept uniform and simple and is supported by additional functions like search, recent changes or the possibility for the user to select specific pages for monitoring. Any article can be assigned to one or more categories, which is used as a simple structuring mechanism. Furthermore, the use of formatting templates is supported which can help to create and maintain an internal (informal) structure of the content.

In knowledge management research wikis are widely perceived as potent knowledge management instruments (e.g. O'Leary, 2008, Wagner, 2006). And also in the IWRM domain, some organizations have recently started initiatives of which probably the most visible examples are the UNDP-initiated WaterWiki (WaterWiki, 2012) and the IWAWaterwiki (IWAWaterWiki, 2012).

Most perceived limitations of conventional wikis are rooted in a lack of formalized structure. From a (knowledge-) structural viewpoint a wiki-page is a subjective and informal collection of information elements residing implicitly in the linguistic content. A computational treatment of knowledge, however, requires formalization at least on a conceptual level which includes a representation of relationships between expressed terms Guarino (1995).

Also the hyperlinks between ordinary wiki-pages do not add any semantic information because every link has the same meaning. For example, a link that refers from the wiki-article on the city of As-Salt to the article on Jordan has the exact same explicit meaning as the link pointing back to the wiki welcome page (Fig. 3a). It is thus not possible for a machine to recognize the meaning of that link as “located in” and to answer a question for all cities located in Jordan. Answering such queries typically is done by using manually crafted and updated lists.

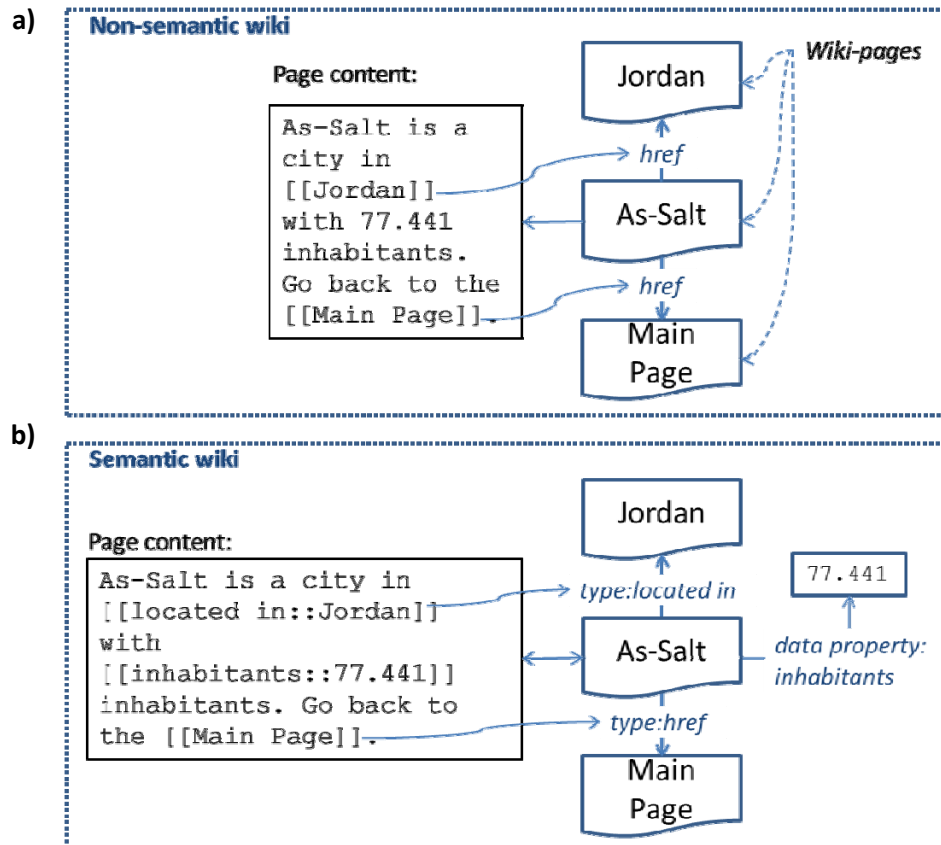


Fig. 3: Difference between **a)** ordinary links in non-semantic wikis and **b)** typed links as structural elements in semantic wikis (here using the Semantic MediaWiki markup (SMW, 2012)).

Consideration of these limitations has led to semantic wiki development initiatives. Semantic wikis basically expand the wiki-technology with the possibility to create a formal semantic knowledge representation of the wiki content by annotating the content on the wiki-pages with a special markup. An overview of general architectural features can be found in Oren, et al. (2006). The level of formalization of page-content that is realized with such annotations varies between the different wiki-engines as well as with the purpose of the wiki. The typical approach is to represent one ontological concept (e.g. a city, a spring, etc.) as one wiki-article. Formalized statements about the concept are made by annotating article content as “typed links”, which include information about the character of the relation. Using the example from above, the hypertext link between the As-Salt and the Jordan articles would be annotated as in Fig. 3b, thus formally stating that As-Salt has an attribute (*located in*) which can be given a value (*Jordan*). Hereby, most semantic wikis internally represent the graph of typed pages and links in RDF/OWL (or some subset) (Buffa, et al., 2008). This allows differentiating between typed links in regard to the datatype of their object into object properties (object of the typed link is a wiki-page or some external document) and datatype properties (object is a data value). Eventually, the sum of statements within the wiki-content creates a machine interpretable ontology (“wiki-ontology”). Using this “wiki ontology” enables a series of supportive features for contributors, such as help to find the right place for

their contribution and suggest structural elements (e.g. links to existing content) during contribution. By allowing “inline queries” on the formalized structure it supports better and direct search, various representation possibilities (e.g. automatic generated and updated lists, tables, maps, etc.) and extraction of content. Another advantage of querying is that an information element (e.g. the number of inhabitants) can be kept on one wiki page (e.g. the article of As-Salt) but displayed on other pages (e.g. in a list of Jordanian cities) without copying the number, which helps to keep information consistent.

1.5 Knowledge Representation with Semantic MediaWiki

Different semantic wiki software products have been under development (Buffa et al., 2008). For this study the “Semantic MediaWiki” (SMW) project (Krötzsch et al., 2006) was chosen, primarily because it is one of the semantic wiki engines that has grown and stabilized during the last years. SMW originated from the AIFB Institute at the University of Karlsruhe as an open source extension to the well-known MediaWiki software and has attracted a large developer and user community today.

SMW extends the MediaWiki syntax with expressions for semantic annotations within the wikitext. Annotations are formalized through a mapping to Ontology Web Language (OWL) entities. Wiki articles match OWL individuals and the annotations always take their page of occurrence as subject individual to make OWL DL ABox (assertional box) statements similar to RDF triples, thus allowing to

- (1) assert a relation (OWL:object-property) to another wiki-page (OWL: individual)
- (2) assert a property (OWL: data-property) and literal of the current page (OWL: individual)
- (3) assert a category (OWL: class) to the the current page (OWL: individual)

The following briefly and not comprehensively describes some fundamental structural elements that are used in subsequent sections. Detailed syntax documentation can be found in the user manuals on the MediaWiki (MW, 2012) and Semantic MediaWiki (SMW, 2012) sites and in architectural detail in Krötzsch et al. (2006) and Bao, et al. (2008).

Pages are the key structural entities in wikis and also in SMW, as they contain all annotations. Pages are identified by their page-title and are created by calling their URL in or through linking to them from an existing wiki page (e.g. `[[New Article Name]]`). Basically, it can be differentiated between article pages and non-article pages. Article pages correspond to OWL individuals. It is therefore recommended to see articles as distinct knowledge entities, i.e. a certain spring or a city, that only contain information about themselves, either as implicit context knowledge in text form or as explicit metadata in form of relations and data-properties. Non-article page-types include:

- (1) category-, property- and data-type-pages: automatically created on demand and meant to be edited for ontology formalization.
- (2) template- and form-pages: created manually as assistant elements.
- (3) special-pages: system-created to perform specific functions and usually not meant to be edited.

Properties are automatically created by property-annotations on wiki-pages. For example the article-page of As-Salt containing `[[is located in::Wadi Shueib]]` automatically creates the *Property:Is_located_in* with the default *data-type range:page* and instantiates an individual thereof on the As-Salt page with *value:Wadi Shueib*. Changing the default data-type (page) to another type, e.g. a number, can be done on the non-article page of the property by annotating it with `[[has type::number]]`. Thereby, SMW allows definition of OWL:object properties (page-types) and OWL:data properties (other types).

Categories are automatically created by a category-annotation on a page to add an OWL-SubClassOf-relation to a page. Annotating for example the As-Salt page with `[[Category::Municipality]]`, classifies the article-individual as a municipality. Adding the category annotation to a category page creates a hierarchical relation. SMW does not restrict the amount of categories a page belongs to, but understanding categories as OWL:Classes recommends to use a single (or few) category-classification.

Semantic Internal Objects (SIO) are an extension to the SMW core that provides an additional parser functions to define objects and associated properties from within a wiki page. Internal Objects are annotated on a page by:

```
{{#set_internal:object_to_page_property|property1=value1...}}
```

and handled as page-like objects (pages without an article representation), thus, allowing their properties to be queried separately. SIOs can be used to represent n-ary relations in a wiki environment, without the need to create new pages for every multidimensional information element.

Inline queries are inserted into a page and allow querying annotations in the wiki ontology. The query syntax is SMW-specific and uses the pattern:

```
{{#ask: [[condition 1]] [...] [[condition n]]
|?printout parameter 1|?...|?printout parameter n
|format parameter 1|...| format parameter n}}
```

The condition argument are used for selection and can include category selectors, property selectors, comparators (for property selections), OR disjunctions and property chains. While the condition arguments return a list of pages, the printout parameters state which page properties are to be fetched and displayed in the query results. Format parameters define the display format results (e.g. as list, table, map, etc.).

Templates are pages of the template-namespace that are embedded into other pages, when called by

```
{{name_of_the_template_page|optional_parameter_1|...|n.  
While the template page contains wiki-text, as well as  
placeholders for the parameters as optional_parameter_1}}.
```

Thereby, templates generally enable structuring, formatting and reusing of wiki content and are already very popular in non-semantic MediaWiki applications (e.g. Wikipedia). In the SMW community, the use of templates is also perceived as very advantageous, as they provide an interface between wiki editors and the wiki ontology. In this respect, using template parameters to handle semantic annotations basically saves users from the necessity to search the ontology structure for the correct properties before contributing formal content.

Semantic Forms are an extension to SMW that allows using form-based input masks for wiki editing and querying. Forms are constructed as pages in the Form-namespace where the input fields and their behaviour are defined and mapped to one or multiple templates. The definition of input field behaviour reflects certain aspects of the *rdfs:domain* and *rdfs:range* properties in OWL which can be used to support as well as control user input. Actual semantic annotations are still defined within the templates, thus, making the semantic forms another interface layer on top of templates.

2 SMART KNOWLEDGE MANAGEMENT

2.1 General Design

As stated in the previous sections, a knowledge management strategy must be adapted to the given environment and the people that eventually are both: the providing and receiving end of the knowledge. Following the experience from the Wadi Shueib IWRM modelling exercise (Riepl, 2013), as well as discussions in the community of the SMART project, it was established that this predominantly relates to sector experts and decision makers. Thus, the knowledge management process basically is the channelling of expert knowledge and decision maker objectives towards the IWRM planning process. Expert knowledge hereby comprises the manifold pieces of information that researchers and practitioners gather, create and employ in their working routine in order to acquire the desired system understanding. These might span from individual calculation or estimation procedures applied to obtain model parameters, over a full model application and up to complete scientific studies. While the latter would at least be likely to progress into the classical channels of publication and reporting, especially the smaller information entities, however valuable, are often never fully disclosed to a wider audience. On the other hand they might well be interesting for other researchers or practitioners working in nearby or comparable areas to be informed about such work, as much as any idea could benefit from being discussed by an interested audience. Acknowledgement of these requirements led to the broad design decision as illustrated in (Fig. 4) and the definition of the fundamental roles and concepts for the envisaged IWRM knowledge management system:

Fundamental roles:

- **Domain Expert:** Someone who performs analyses on a specialized subject by gathering, combining and inferring information using various sources (literature, models, studies, or his judgment). Creates knowledge in the work process (knowledge creator).
- **IWRM Analyst:** Someone who uses a set of defined goals (policy) and the pool of available knowledge about options and constraints (feasibility, cost-benefit) to perform an IWRM planning and decision process. Also includes the role of **Decision Maker**.
- **Knowledge Engineer (also Administrator)** (not depicted in **Fehler! Verweisquelle konnte nicht gefunden werden.**): Someone who maintains the knowledge management system both in technological as well as in structural sense. Evolves and adapts the knowledge management process to the

Fundamental concepts:

- **Expert Analysis:** The expressible product of the analysis process of an expert (e.g. the calculation or estimation of a single value, a literature study, a complex model

application or a full scientific study). Related to a distinct entity with significance in the IWRM Process.

- **IWRM Object:** Something that has significance for IWRM, has information about itself and stated relationships to other entities. Can be a tangible entity such as a study area, a spring, a city, a waste water treatment facility, or an intangible entity such as an indicator, a scenario, a literature reference). Can also have a representation in the database.
- **IWRM Process:** IWRM planning and decision process applied to a defined area. Builds on the available information about the associated entities and the given decision constraints and objectives.

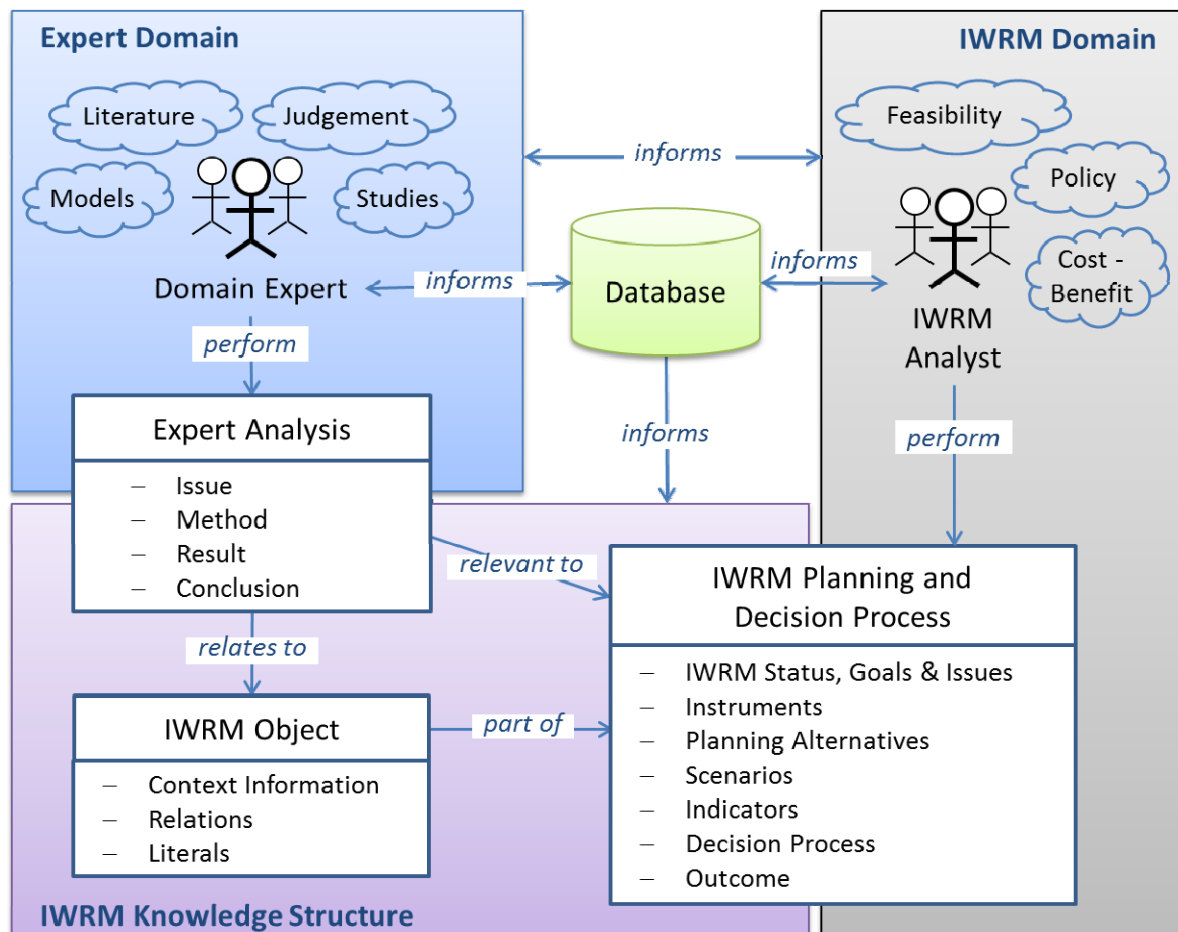


Fig. 4: Fundamental concepts and user roles in the IWRM knowledge process.

Thus, the general approach of the SMART knowledge management system is to offer an instrument that allows **domain experts** to formulate their **analyses** and structure them by linking to respective interrelated entities (**IWRM-Objects**) which represent the IWRM system. Members of the IWRM domain (**IWRM-Analyst**) on the other hand are enabled to

identify and select from the available information to formally document their Decision and Planning processes (**IWRM-Processes**). Formally linking between a database and the entities in the knowledge base (mostly with the IWRM-Objects) establishes an integration of the knowledge management instrument into an overarching information system. The ultimate goal is to evolve a well-structured IWRM knowledge base that provides rich application-level information from experts for experts, IWRM-analysts and decision makers and integrates smoothly into a holistic planning and decision practice.

In order to compose an a-priori knowledge representation structure that suits these fundamental concepts, as well as the exemplary use cases identified from the Wadi Shueib IWRM study, a semi-formal class structure of IWRM-Entities was developed (Riepl, 2013). The choice of represented concepts was initiated from a set of typical water system model nodes as well as from the planning process model used in the IWRM concept. The focal point was chosen to be the ‘catchment’ concept, with all spatial relations pointing towards (or from) it. In several iterative modelling steps the initial concept list was refined and organized in hierarchical (*is_a*) and non-hierarchical relations (e.g. *located_in*) until an applicably generic representation of the IWRM modelling and planning domain, as illustrated in Fig. 5, was found.

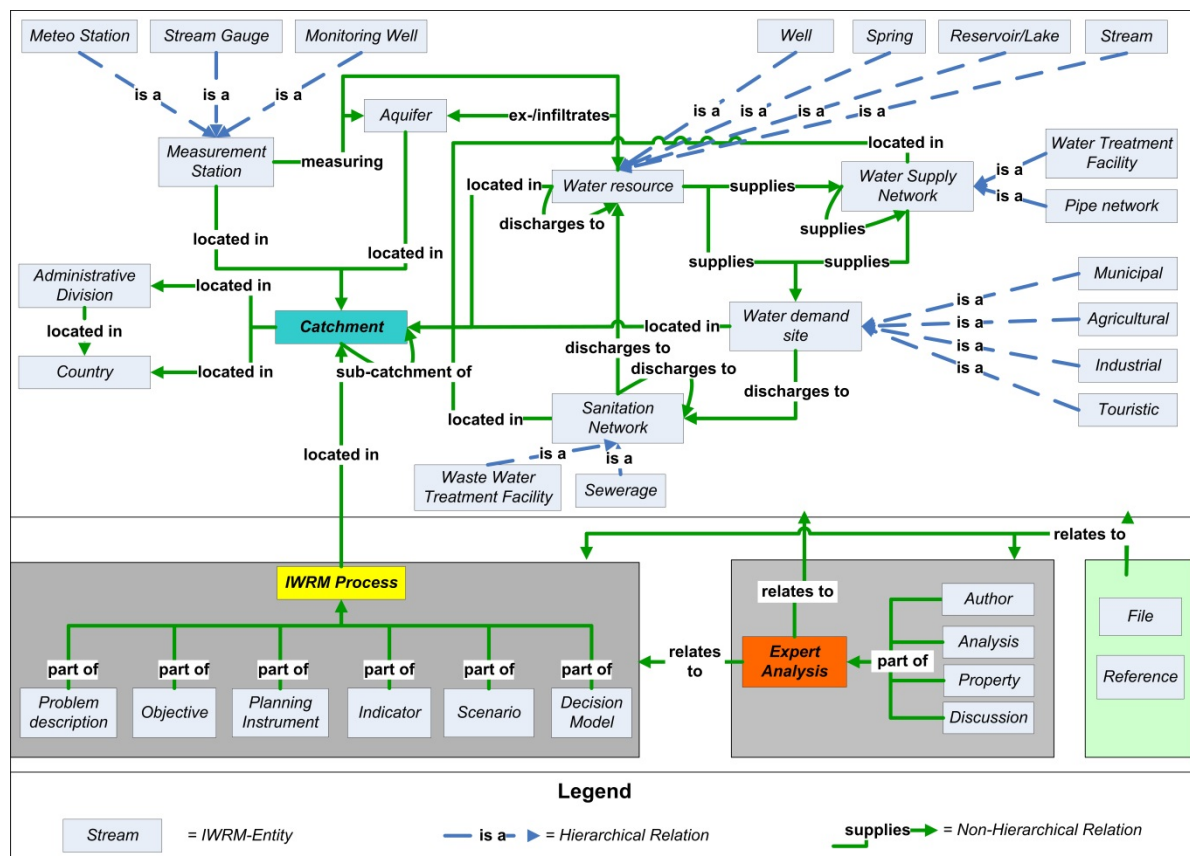


Fig. 5: Class-structure of the semi-formal IWRM-ontology.

2.2 Use Cases

UC-1: Create IWRM-Entity

Scenario: Create the Wadi Shueib catchment or another IWRM-Object, e.g. the Hazzir Spring, in the knowledge base.

Task: Create an IWRM-Entity and add formal relations that describe metadata of the IWRM-Entity, e.g. Hazzir Spring is located in Wadi Shueib, its coordinates, the aquifer it taps, etc.

UC-2: Document Expert Analysis

Scenario: Expert has collected precipitation data and performed a spatial interpolation to estimate areal precipitation for the Wadi Shueib catchment.

Task: Create an analysis entity and add formal relations that describe analysis and results and embed the analysis individual into the IWRM-Entity knowledge structure.

UC-3: Document IWRM-Process

Scenario: IWRM-Analyst starts an IWRM planning study for the Wadi Shueib catchment, which should be documented and shared for collaboration

Task: Create an IWRM-Process entity and add formal relations metadata. Add entities for the steps of the planning process and link them to analyses used in the IWRM-study.

UC-4: Contribute to Existing IWRM-Entities

Scenario: User wants to comment on the areal rainfall-interpolation analysis for the Wadi Shueib catchment to state his opinion and add a literature reference.

Task: Edit an existing IWRM-Object/Analysis/Process by adding or changing formal relations and informal content. Original author and other users are informed.

UC-5: Reuse Knowledge

Scenario: User creates an analysis on groundwater recharge of the Wadi Shueib that uses the areal rainfall analysis.

Task: Add a generic relation to an analysis to refer to another entity, which then also automatically displays the relation.

UC-6: Retrieve Analyses for a Study Area and Subject

Scenario: User wants to retrieve a list of all available analyses on water resources in the Wadi Shueib catchment.

Task: Create a query that asks for analyses with a location relation pointing to a specific IWRM-Object and a subject relation pointing to a specific theme.

UC-7: Link IWRM-Entity to Representation in Database

Scenario: User wants to inform about the available measurement time series of the Hazzir Spring that are stored in the database.

Task: Define an identifier to link from an knowledge base entity to a database object. The knowledge base sends a query to receive information on data-availability and displays the metadata on the respective database object.

2.3 Requirements

Defining the eventual structural, usability and functional requirements for the IWRM knowledge management platform has been an iterative process during the work on the project. Thus, the requirements listed in Table 1 evolve as much from theoretical considerations as from the experienced practicable feasibility within the scope of the objectives.

Table 1: Identified requirements for a collaborative knowledge management platform for IWRM planning and decision support.

Requirements
Knowledge Representation Requirements
IWRM-Entities, Analyses and IWRM-Processes are fully represented.
Multiple representations of knowledge for specific entity and topic are possible.
Formalized relations between all entities are possible.
Representation of n-ary relations.
Formalized relations between entities are represented on both sides (inverse relations).
Support the creation of an analysis-specific formalization vocabulary.
Usability Requirements
Technological barrier for contributors is low.
Users do not need to care about ontology engineering.
Support user in finding the appropriate location in the knowledge base to contribute.
Possibility of generic contribution, if no appropriate location is found.
Possibility to describe entities in a form that is familiar to users, i.e. like writing a short report.
Incomplete formalization of entities is accepted but completion encouraged.
Contributions and edits are immediately represented and communicated.
Spatial information is visualized.
Authorship and contribution is represented.
Functional Requirements
Possibility to add files and external links to all entities.
Support use of relations that are coherent with the ontology.
Edit rights control on IWRM-Entities on contributor side.
Protection mechanism against erroneous edits and/or vandalism.
Interface supports semantic search, faceted browsing and visual information retrieval.
Knowledge Base informs available data from remote data repositories
Knowledge Base is able to interact with external applications

2.4 Implementation

With the DROPEDIA platform, a prototype of a collaborative knowledge management platform for IWRM planning and decision support has been implemented within the scope of the SMART project. After an initial closed development phase, the platform was opened with online access to the SMART project partners (full access) and the public (read only) under <http://129.13.109.100/~dropedia/> (Fig. 6). The following sections provide an overview of essential architecture elements that were implemented to meet the identified requirements.

Based on the classical web-based wiki-concept, the Dropedia-platform is hosted as a client-server-model. At the time of publication of this thesis, the webserver was running on a self-hosted AMD Athlon 64 3000+ (1.8 GHz) machine. Furthermore, Dropedia is completely based on Open Source Software distributed under the GNU General Public License in versions 2.0, 3.0 or under compatible licenses approved by the Open Source Initiative (OSI). The wiki itself is running on a *MediaWiki* installation with a number of extensions that are mostly related to the *Semantic MediaWiki* project. A detailed list of the employed software packages is found in Annex 1.

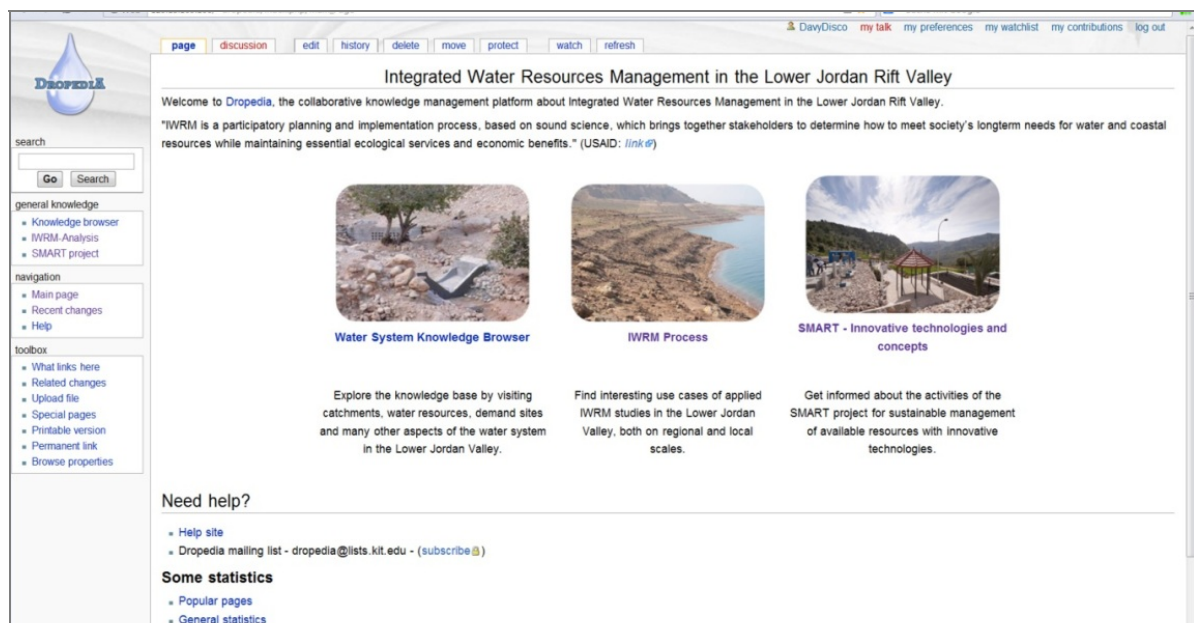


Fig. 6: DROPEDIA welcome screen.

2.4.1 DROPEDIA-Ontology

As a first step, all a-priori identified IWRM-Entity classes were represented as categories. Categories themselves can be annotated as members of a category, thus, allowing a *rdfs:subClassOf* hierarchy that can be used for structuring and querying.

Abundant categorization can, however, also reduce clarity. Therefore, the category hierarchy is kept shallow in the DROPEDIA-Ontology, constituting a maximum of three levels with the top-classes: IWRM-Object, IWRM-Process and Analysis.

For every IWRM-Entity a set of properties was identified that provide a basic formal description of the subject. Formal description of a complex concept, such as a city or a spring, can quickly lead to a high amount of perceivably necessary predicates, especially when considering available knowledge about specific individuals. The latter typically results in the formulation of relations that an entity can have, for example that a spring can have a protection zone, but at the same time distracts from the fundamental attributes that all individuals of the class share. In order to control the amount of necessary properties, the descriptive predicates were iteratively condensed to find least common denominators of property definitions. Eventual properties include a set of descriptions that can be reused for different concepts (e.g. spatial descriptions like *is_located_in*, *has_coordinates*, *has_area*, or general descriptions like *has_reference*, *has_file*). Category-specific properties are only added for very common and stable attributes, (e.g. *has_aquifer_tapped* for springs and wells).

Property definition includes the various built in types, as well as a set of customized data-types, (e.g. area, flow, water type) that allow additional control on input (*swivt:allowedValue*) and representation (*swivt:mainUnit* and *swivt:conversionFactor*).

Since the SMW-model, as OWL/RDF in general, does not support propagation of properties from categories to individuals, the assertion of the metadata properties was realized by assigning templates to each category which handle annotations when an instance of a category is created.

SMW also lacks native support of property ranges (*rdfs:range*) which can significantly help users in ontology-coherent knowledge formulation. As an informal workaround, property ranges were implemented via input data types in Semantic Forms input field definitions (with “values from= x“, where x is a specific category, property or namespace).

The combination of several requirements posed a challenge on the DROPEDIA-Ontology:

- (1) Users must be able to represent multiple views on one property. Therefore, and because information cannot practically be atomized to unambiguous one-dimensionality in a wiki environment, users must be able to represent n-ary relations in DROPEDIA.
- (2) An a-priori knowledge model cannot provide formalisms for all probable representation requirements. Therefore, users should be able to extend the basic vocabulary with own terms.
- (3) Users should not have to bother with ontology issues and are thus strongly supported by predefined form inputs.

Separating knowledge representation into IWRM-Object entities and related Analysis entities basically solves the first of above issues. In doing so, an IWRM-Object (e.g. a municipality) can relate to any number of views (e.g. have several related population analyses).

The creation of a generic formalization mechanism with the use of the Semantic Internal Objects (SIO) extension tackles the second and third issue. Each Analysis individual can contain an unlimited number of SIOs which represent user-defined n-ary properties.

2.4.2 User Interface and Interaction Architecture

DROPEDIA is primarily intended to interact with human agents. In order to facilitate ontology-coherent contribution without the hindrance of first searching and understanding the DROPEDIA-Ontology, the platform was set up to make strong use of templates and semantic forms for user input and content presentation. Fig. 7 illustrates the setup of the interface architecture from a user perspective.

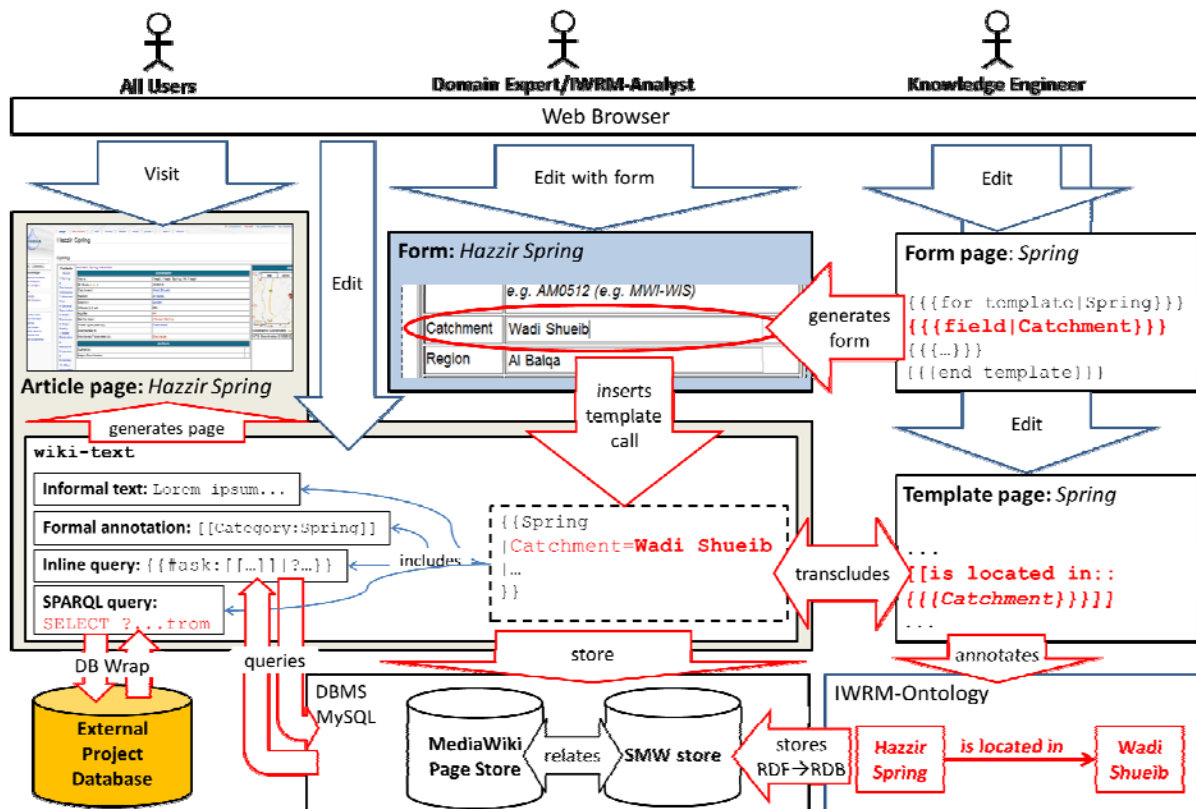
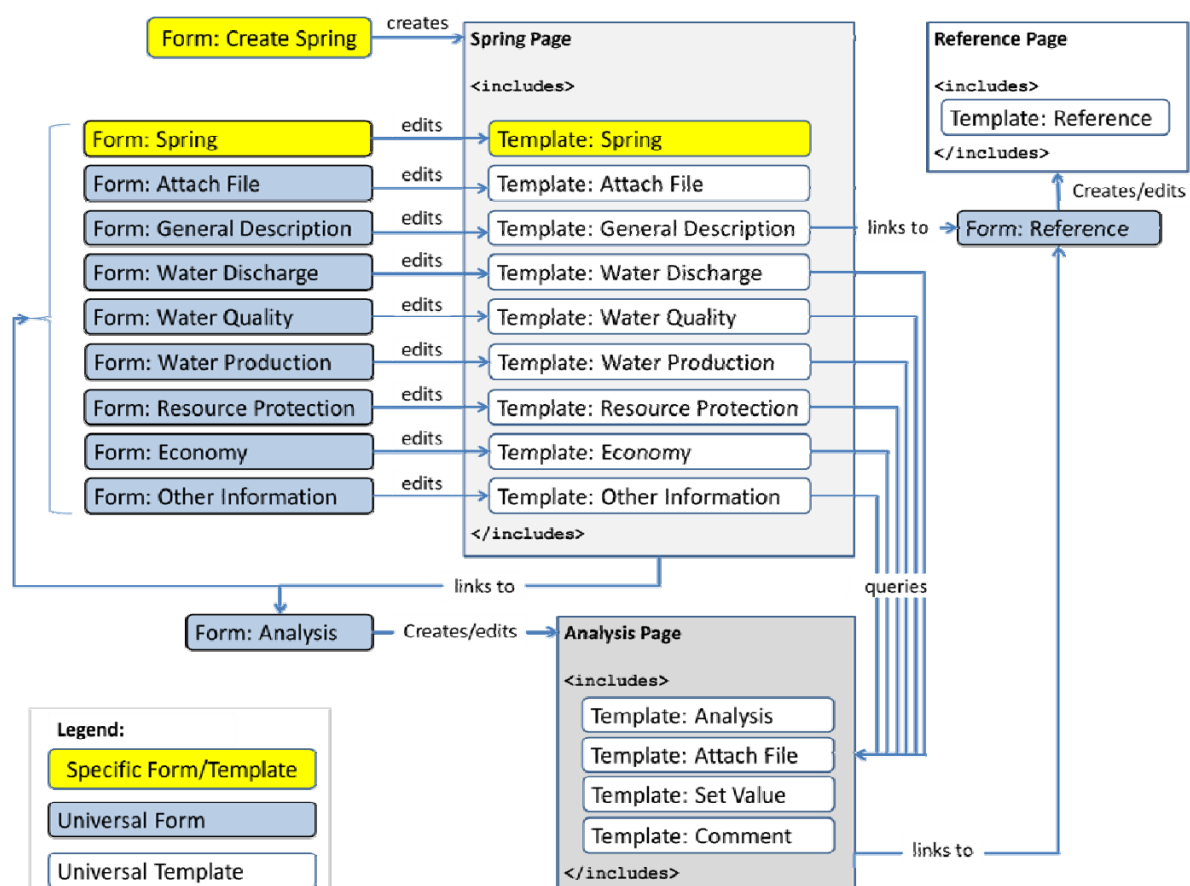


Fig. 7: User interface architecture of DROPEDIA. All users can browse pages. Domain Experts and IWRM Analysts can use forms to edit the information on the pages. The Knowledge Engineer ensures semantics and functionality by providing the forms and templates.

All IWRM-Entity categories have assigned specific input forms that can be used to add and edit articles. Forms always consist of input fields for the metadata properties of the respective category, as well as a free-text input possibility. For most fields input is voluntary, so as to enable contribution even when not all facts are known. Saving an edited form inserts a template call into the wiki text of the article page with the input as template parameters. The transcluded templates fully handle page layout, semantic annotations as well as ask- and SPARQL-queries. Besides the encouraged use of forms and templates, directly editing a pages wiki-text is also kept as possibility, in case the controlled environment is not sufficient.



2.4.3 Connection to the SMART Project Database

As a wiki-based knowledge management platform, DROPEDIA does not compete with relational database management and is neither intended, nor fit, for the efficient handling of large alphanumerical or spatial datasets. On the other hand, it is very useful to let the knowledge base inform users about the availability of data on a specific IWRM-Object in remote data repositories. In this sense the wiki platform can act as an integrative frontend that lets users combine information

For this purpose, a query module that allows representation of SMART Database content in DROPEDIA pages was developed. Implementation of this module was primarily done within SMART work package 2 and is documented in more depth in Deliverable D203 (Kaempgen, et al., in preparation). The general architecture is illustrated in Fig. 9. The implemented query module receives the data by HTTP request from a Linked Data Wrapper that wraps daily generated database views from the HYDROSMART XML/HTTP interface. The wrapped data is filled into an online triple store (Qcrumb.com), thus allowing semantic queries from DROPEDIA to be issued with a SPARK query syntax.

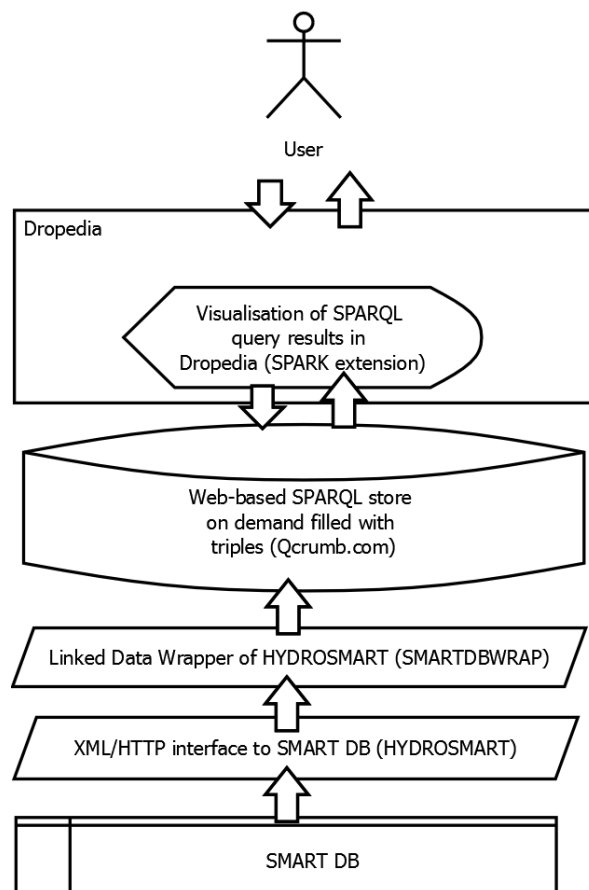


Fig. 9: Architecture of DROPEDIA/SMART-DB connection (Kaempgen, Riepl, Vrandecic and Hermann, in preparation)..

2.4.4 Use Case Workflows

This section briefly illustrates how the previously defined use cases (UC) were realized as workflows in DROPEDIA. For this section, the description follows the illustration in Fig. 10, although, there are several other possible paths to navigate and interact with the platform to achieve the tasks defined in the use cases.

Users may start on the welcome page or via the permanent left-side navigation and search panel (1) to open to the DROPEDIA Knowledge Browser page (2) which offers an overview of the knowledge base content. Since the overview is automatically created with inline queries at every page load, it always presents an up to date view on the content. The query results are organized as IWRM-Objects in sections that correspond to the DROPEDIA -Ontology categories and are displayed in table as well as in map format.

To add a new IWRM-Entity to the knowledge base (UC-1), every section offers an “Add [IWRM-Object]”-link (3) that opens the respective input form (4) with fields for the categories metadata-properties. Various helpful features of the Semantic Forms extension are realized, including: auto-completion of input according to the defined property ranges, file uploads, map-navigation for geographic locations as well as geocoding of addresses. Saving the form (5) creates the article page for the IWRM-Object (6), displaying the defined metadata properties, attached files and a series of sections that represent primary topics of the subject (e.g. a spring page shows sections for water discharge, water quality, e.g.).

Every section can be edited by any (logged in) user by following the displayed “Add/Edit [Section]” links that lead to a corresponding form input (7). Generally, every IWRM-Object, Analysis or IWRM-Process page offer respective links, thus allowing successive updating and commenting of the knowledge base content (UC-4).

Article pages also present a graph-view (8) on available data in the SMART Database, created by an embedded SPARQL query at every page load (UC-7).

To create an analysis and add it to the IWRM-Object of the current article, users can follow the “Add [Section] Analysis”-link (9) to open the Analysis-form (10) that provides input fields for Analysis metadata properties, file uploads and free text, as well as multiple instance form fields to add an unlimited number of user-defined properties that are stored as SIOs (UC-2). Furthermore, the *related_to* property can hold a list of IWRM-Object- or Analysis pages to create relations and reuse information between knowledge elements in DROPEDIA (UC-5). Saving the Analysis form creates an Analysis-page that displays the input and queries the stored SIOs. The latter are also displayed in a query on the article page of the related IWRM-Object (11). The workflow of documenting an IWRM-process (UC-3) is not illustrated here, but it basically follows the same scheme as the creation of an IWRM-Object.

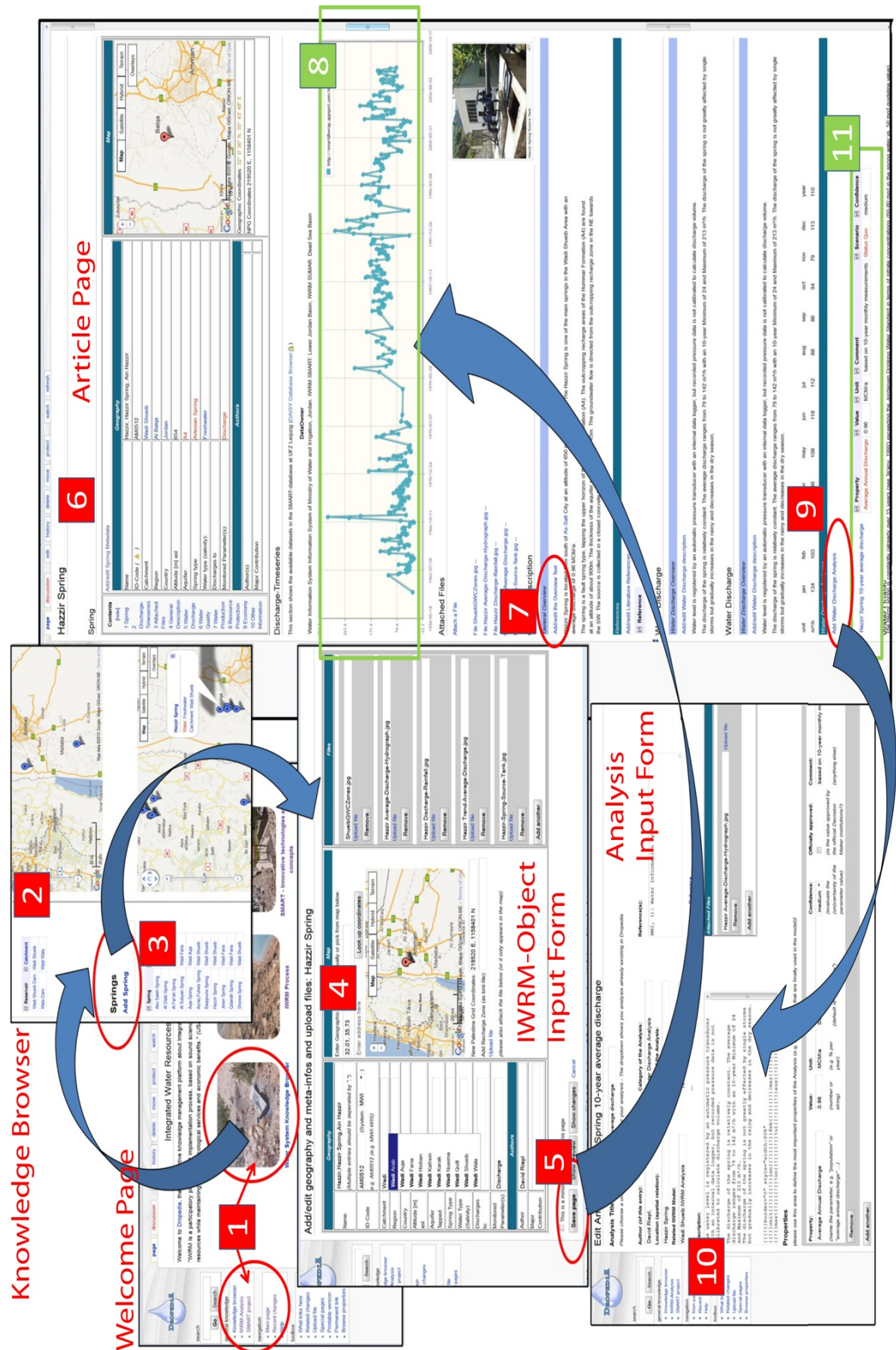


Fig. 10: DROPEDIA workflow for IWRM-Object and Analysis contribution.

2.5 Evaluation

The following section evaluates to which extent the previously identified IWRM knowledge management requirements could be met in DROPEDIA and which requirements could not or have not (yet) been implemented. At the time of publication, DROPEDIA has already been opened to project partners, but has so far not achieved extensive usage within the SMART project. Thus, the presented evaluation has to rely in large parts on a preliminary and informal assessment of the knowledge platform potential.

2.5.1 Knowledge Representation Requirements

IWRM-Entities, Analyses and IWRM-Processes are (fully) represented.	yes
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The statements of the preliminary semi-formal IWRM-Ontology are represented in the DROPEDIA-Ontology and all concepts are described by a set of meta-data properties. Full representation, however, also implies completeness, which appeared as not feasible in the broadness of the IWRM domain. In this regard, the DROPEDIA-Ontology is meant to evolve with its use.

Multiple representations of knowledge for specific entity and topic are possible.	yes
Representation of n-ary relations.	(yes)
Support the creation of an analysis-specific formalization vocabulary.	yes

The separation of IWRM-Object entities and related Analysis entities provides a working solution for the representation of multiple views and n-ary relations.

Knowledge representation is not necessarily fully formalized, as the level of aggregation or segmentation of analyses as well as the optional formulation of properties with SIOs, is basically left to user choice. Yet, the three layered model of: IWRM-Object $\leftarrow is_related_to$ $\leftarrow$ Analysis $\rightarrow has_value \rightarrow$ SIO, does not represent n-ary properties in a strict sense and requires nested queries for retrieval. Also users might not intuitively understand this threefold separation.

Formalized relations between all entities are possible.	(yes)
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Basically, by editing a pages wiki-text any relation can be defined. This was only partly realized in the input forms, basically for the Analysis *is_related_to* and the IWRM-Process *includes* relations. Generic relations between IWRM-Object might be another useful addition to the DROPEDIA-Ontology.

Formalized relations between entities are represented on both sides (inverse properties).	(no)
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In newer versions of SMW it is possible to query for the inverse direction of a property. However, this does not assign the property to the targeted object.

2.5.2 Usability Requirements

Technological barrier for contributors is low.	yes
Users don't need to worry about ontology engineering.	(yes)

The wiki environment generally set the technological barrier low. Users only need a standard web-browser to access DROPEDIA and, owing to Wikipedia, are usually well adapted to the typical wiki-style navigation. The structural formalism introduces an abstract complexity that was heavily overbuilt by the use of forms and templates. On the other hand, several interesting functionalities are still reserved to proficient users with some understanding of the SMW markup and the DROPEDIA-Ontology. Foremost to mention are the possibility to create own queries or to extend the ontology.

Support user in finding the appropriate location in the knowledge base to contribute.	yes
Possibility of generic contribution, if no appropriate location is found.	yes

Several structural elements were implemented for this purpose. Especially the DROPEDIA-Knowledge Browser is designed to provide quick and structured overview of the knowledge base content and allow direct access to contribution. But as mentioned before, the necessary separation between the fundamental concepts is not intuitive and is likely to result in some need of introduction for new users. All input forms also provide free text fields for generic and informal contributions. Furthermore, any contributor has the possibility to create unstructured ("normal") wiki pages.

Possibility to describe entities in a form familiar to users, i.e. like writing a short report.	(yes)
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Pre-setting of a certain structural requirement is unavoidable for formalization. And it disregards the advantages of the semantic structuring to just copy/paste reporting text into DROPEDIA pages. Still, due to abovementioned informal input possibilities, as well as the generic setup of the Analysis category, the level of formalization is to the greatest possible extent left to user choice.

Incomplete formalization of entities is accepted but completion encouraged.	yes
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Only few metadata properties critical for structuring are set to mandatory input.

Contributions and edits are immediately represented and communicated.	(yes)
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New contributions are by default directly represented on the edited pages. Furthermore, several native MediaWiki-tools like "History", "Recent changes", or "Related changes" support tracking wiki changes. Interesting changes might, however, be obscured, as these functions record all changes, regardless of the significance. The Knowledge Browser provides an automatically updated structured overview, as do the immediate query representations of new Analysis relations on IWRM-Object pages. Further interesting and also readily available improvements could for example include a "Newest Article" feature on

the main page as it is known from other wikis, or the possibility to mark specific pages of interest in order to receive automatic email change notifications.

Spatial information is visualized.	yes
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With the use of the Maps and Semantic Maps extensions, the representation of point-coordinates and kml-files is possible on the base maps of several web mapping services (googlemaps, openlayers, osm, yahoomaps). Inline queries can have map representation as result format.

Authorship and contribution is represented.	yes
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To emphasize authorship and contribution beyond the native and relatively anonymous wiki standard, the specific metadata-properties *has_author* and *has_contributor* were introduced. Secondly, editing rights are restricted to registered users.

2.5.3 Functional Requirements

Possibility to add files and external links to all entities.	yes
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File uploads and external links are basic MediaWiki functionalities that were consistently employed in the input forms.

Support use of relations that are coherent with the ontology.	yes
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General ontology-coherence is realized through the use of templates for annotation handling and semantic forms for user input. A possibly useful addition thereto, could be to offer of an ontology-browser interface that allows more proficient users to conveniently explore categories, properties and instances. The native possibility, to list these entities on their corresponding Namespace-overviews is too unrelated to help understanding of the structuring.

Protection mechanism against erroneous edits and/or vandalism.	yes
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Edit rights control on IWRM-Entities on contributor side.	no
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Wikis are fundamentally built on the principle of open editing. Nonetheless, the “Revision History”-function of wiki-pages provide a capable protection mechanism against erroneous or unwanted edits. Another possibility also discussed for DROPEdia, was to give authors of articles the control on edit rights. The Access Control List MediaWiki extension that introduces such functionality was tested in the prototype phase, but eventually dropped due to compatibility problems.

Interface supports semantic search, faceted browsing and visual information retrieval.	(yes)
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Facetted navigation is generally supported by the article-templates and the Knowledge Browser, which both support map display and query-generated structured content. Semantic search is also possible, but still lacks satisfactory support for non-proficient users, as it requires understanding of SMW markup and the ontology structure.

Knowledge Base informs available data from remote data repositories	(yes)
Knowledge Base is able to interact with external applications	(no)

An informative connection to the SMART-Database was realized, which allows to query a daily database-view and represent the results in DROPEDIA-Pages. The modular approach is suitable to be extended to other distributed data-repositories. External application interaction is also basically supported through the SMW functionality that allows the import and export of RDF statements. This, however, was not tested until the publication of this report.

2.6 System Status and Usage Statistics

At the time of publication of this thesis, the discussed DROPEDIA platform had been opened to contributions by SMART project partners and stakeholders for about one year. Concept, design and functionality generally perceived approval from the project community as well as from the international IWRM community, when presented at international symposia (Riepl, et al., 2011). And sector experts signaled interest and willingness to invest time into a wiki-based knowledge platform.

However, as the actual usage statistics delineated below reveal, adaption of DROPEDIA has not yet reached the anticipated level.

DROPEDIA Statistics (November, 2012):

- 154 content pages
- 187 uploaded files
- 5 active editors
- Views total: 165,444

Although the number of view counts suggests an interested community, the lack of active contributors (5 out of a project with more than 50 participants) documents the reluctance of the targeted audience to actively employ the system to its full purpose.

A brief review of other online communities reveals related challenges that are often called the “1% rule” or the “Participation Inequality”. The basic hypothesis is that in most online communities user participation more or less follows a 1-9-90 distribution, with 1 % regular and 9 % occasional contributors as well as 90 % that only consume (Nielsen, 2006). Another important aspect of reluctant contribution might be the difficulty to design a good integration into the day-to-day workflow of the targeted audience, due to their heterogeneity. In this regard, contributing might be perceived as additional work. And a third essential reason is most likely linked to the fear of losing control over one’s personal knowledge assets and in the worst case having others copy or exploit the personal work.

3 CONCLUSIONS

The demand for improved communication and transparency between participants in the IWRM process is regularly pointed out in the literature. The IWRM domain, however, still lacks exploitation of this potential. This report and the foundational work documented in Riepl (2013) demonstrates the first consequent development of a semantic knowledge management framework for collaborative planning and decision processes in Integrated Water Resources Management. The focus was placed on what was perceived as one of the most urgently required aspects: the collaborative documentation and sharing of planning and decision relevant system understanding during the IWRM process. It could be demonstrated, how such processes can be reasonably formalized and efficiently managed in a semantic structure that is strongly directed towards knowledge sharing.

Aspects of water sector knowledge have been previously represented in ontologies. Earlier studies, however, focused mostly on strict and rule-based representations of small sub-domains, with the objective of enabling expert system-like functionalities for user-guidance (e.g. Ceccaroni, et al., 2004, Scholten, 2008, Volk, et al., 2007). In this regard, the semi-formal IWRM-Ontology, as well as the deduced DROPEDIA-Ontology, are unique developments that eventually achieved a satisfactory expressive potential for the applied use cases. Nonetheless, the ontologies are profoundly meant to evolve with their use. Together with the necessary maintenance and extension of the template and form-driven user interaction model, this emphasizes the importance of a strong and dedicated knowledge engineer role for running a collaborative knowledge management platform in the complexity of the IWRM domain. A clearly structured uniform template- and form architecture significantly helps with the required maintenance and necessary extensions.

Recognition of the essential necessity of a strong collaborative element, in addition to structural functionalities, led to the eventual choice of the semantic wiki approach.

In the IWRM context, it was experienced that especially a low technological-barrier and a general easy usability are essential for contributors to adapt to a new system. Thus, in order to handle the structural formalism DROPEDIA consequently employs semantic forms and templates to build a straightforward user-centred interface-architecture. In conjunction with the structural setup of the DROPEDIA-Ontology and the use of Semantic Internal Objects, this also provides users control on the formalization level of their contributions, while at the same time they don't have to be concerned about the tedious and complex task of ontology engineering.

It is expected that comparable activities can greatly benefit from the use of the presented framework or in general from the application of semantic knowledge management techniques. The incentive on the side of researchers and practitioners lies primarily in the prospect to receive a direct and fast feedback from a widened community of interest as well as from their stakeholders already during the course of their work. Stakeholder could use this channel to stay constantly informed about on-going research as well as to take influence by expressing their direct requirements. Moreover, better documentation of models and

modelling processes usually resides high on the wish lists of practitioners that adopt models from research initiatives for their own work. And another very essential incentive for enhanced documentation is the considerable loss of skilled personal (“brain drain”), under which especially developing countries are constantly suffering.

4 OUTLOOK

The semantic knowledge management approach presented in this study has been a novel way for an IWRM initiative. In this regard, it had constantly to deal with a wicked chicken-egg problem: Ideally, a functional knowledge management would have been available from the beginning of the project – but to know which and how IWRM knowledge has to be managed could only be learned during the project. In this respect, future IWRM initiatives are urgently advised to specifically address this task. And not only as a side activity assigned to domain experts or the overall project management, but as a dedicated effort for fostering communication and collaboration.

The presented knowledge management approach has also focused primarily on knowledge sharing. A multitude of emerging applications demonstrated in other disciplines, suggest a considerable potential to extend the presented framework to further knowledge management tasks, like knowledge acquisition or knowledge application. One example could be to investigate the possibility to include the growing open data repositories (e.g. Linked Open Data (LOD, 2012)) into queries conducted from within the knowledge base.

DROPEDIA also bears potential for interesting development potential in terms of structural features. First of all, it could be useful to review and the current caching strategy of DROPEDIA. With the Alternative PHP Cache (APC, 2012) and the Squid cache (SQUID, 2012), two supportive caching modules have already implemented which appear to improve parsing response times, but there has not yet been a systematic validation.

Due to stability reasons, DROPEDIA has been kept running on an SMW version, that has already been outdated at the time of publication of this thesis. It could be very interesting to thoroughly investigate the added functionality of new core and extension versions, especially in respect of newly added querying and result presentation possibilities. A possible use case could be the dynamic graph representation of semantic content, e.g. in the form of a water balance scheme that dynamically represents its elements according to their data values.

Eventually, a more thorough evaluation of the user interface and the use cases could provide valuable insights into future enhancement potential. For example by applying small scale usability tests as presented in Lange (2011), or, after a longer period as an evaluation of usage patterns and discussion culture.

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APPENDIX

Appendix 1: Software packages employed for the Dropedia-platform

Component	Author/Developer	License	Reference (all last accessed on: 02/10/2012)
<i>Basic Modules</i>			
Debian	Debian Project	GPL-2.0+	http://www.debian.org/
Apache HTTP Server	Apache Software Foundation	Apache License 2.0	http://httpd.apache.org/
PHP	The PHP Group	PHP License	http://www.php.net/
MySQL	Oracle (formerly Sun, MySQL AB)	GPL-2.0	http://www.mysql.com/
Squid	The Squid project	GPL	http://www.squid-cache.org/
<i>Wiki-Modules</i>			
MediaWiki	Wikimedia Foundation	GPL-2.0+	http://www.mediawiki.org/
<i>Apc</i>	N. Laxström	NN	http://www.mediawiki.org/wiki/Extension:APC
<i>ImageMap</i>	T. Starling	Any OSI-approved	http://www.mediawiki.org/wiki/Extension:ImageMap
<i>ParserFunctions</i>	T. Starling	GPL-2.0	http://www.mediawiki.org/wiki/Extension:ParserFunctions
<i>Maps</i>	J. De Dauw and others	GPL-2.0+	http://mapping.referata.com/wiki/Maps
Semantic MediaWiki	M. Krötzsch, D. Vrandečić, J. De Dauw, Y. Koren & various others	GPL-2.0+	http://www.semantic-mediawiki.org/
<i>Semantic Forms</i>	Y. Koren and others	GPL-2.0	http://www.mediawiki.org/wiki/Extension:Semantic_Forms
<i>Semantic Maps</i>	J. De Dauw and others	GPL-3.0+	http://mapping.referata.com/wiki/Semantic_Maps
<i>Semantic Internal Objects</i>	Y. Koren	GPL-2.0	http://www.mediawiki.org/wiki/Extension:Semantic_Internal_Objects
<i>Semantic Result Formats</i>	Various	GPL-2.0+	http://semantic-mediawiki.org/wiki/Help:Semantic_Result_Formats
<i>Spark</i>	J. De Dauw	GPL-3.0+	http://www.mediawiki.org/wiki/Extension:Spark
<i>Validator</i>	J. De Dauw	GPL-3.0+	http://www.mediawiki.org/wiki/Extension:Validator

Appendix 2: Dropedia Manual



Benedikt Kämpgen
my talk
my preferences
my watchlist
my contributions
log out

page
discussion
edit
history
move
watch
refresh

[2]
[7]
[6]
[4]
[1]
[5]

search

[8]

general knowledge

- Knowledge browser
- IWRM-Analysis
- SMART project

navigation

- Main page
- Recent changes
- Help [9]

toolbox

- What links here
- Related changes
- Upload file [3]
- Special pages
- Printable version
- Permanent link
- Browse properties

Dropedia Mini Manual

Getting Started	
Dropedia is found at	http://129.13.109.100/~dropedia
Reading:	Everyone
Writing:	Registered users only
User:	Your full name
Initial Password:	"peace", change in <i>preferences</i> [1]
Editing Pages	
Add page	Click inside some pages on <i>Add...</i> (e.g., <i>Add Catchment</i>) or go to [8] new page name and click <i>create this page</i>
Edit	Click <i>edit</i> [2] or inside some pages <i>[Edit]</i> or <i>Add/edit some...</i>
Click Save page after each edit!	
Little Helpers	
Upload file:	Upload file [3] and link it from some page (see Some basic wiki syntax) or click on <i>Attach a File</i> inside some pages
Watchlist:	Watch a page by clicking <i>watch</i> [4] Review watched pages in your <i>watchlist</i> [5] Enable in preferences [1] to get notified per e-mail if a watched page is changed
Renaming pages:	Move contents to another page by clicking <i>move</i> [6]
Versioning:	Switch to an older version of the page [7] Don't be afraid to edit, every change is reversible!
Search:	Search with wild card (e.g., <i>Shue*</i>) for or go to a certain page [8]
Help:	More help in <i>Help</i> [9]

Some basic wiki syntax	
Wiki text	Result
" <i>italic</i> "	<i>italic</i>
"" bold ""	bold
"""" bold and italic """"	<i>bold and italic</i>
==heading==	Headings in different sizes
===level 2===	
====level 3====	
=====level 4=====	
[[Link to another page]]	Internal Link to another page on the wiki
[[Link different title]]	
http://www.example.org	External link
[http://www.example.org Text]	External link with description
[[Category:Example]]	Add article to category "example"
----	Horizontal line
* one	Bulleted List
* two	
* three	
# one	Numbered List
# two	
# three	
[[Image:File.jpg]]	Show uploaded image
[[File:File.jpg]]	Link to uploaded file
{{Name}}	Include template "Name"
~~~~	Signature (Link to userpage)
~~~~~	Signature with timestamp

Dropedia – How to start contributing

1. Login to be able to edit
2. Visit “my preferences” to change your default password
3. Visit the “Water System Knowledge Browser” to see what is already available in Dropedia and start creating your study area

The screenshot shows the Dropedia website interface. The browser address bar displays the URL `129.13.109.100/~dropedia/index.php/Main_Page`. The user is logged in as **DavyDisco**, and the top navigation bar includes links for **my talk**, **my preferences**, **my watchlist**, **my contributions**, and **log out**. These links are circled in red, with the annotation **1. + 2.** next to them. The main heading is **Integrated Water Resources Management in the Lower Jordan Rift Valley**. Below this, a welcome message states: "Welcome to Dropedia, the collaborative knowledge management platform about Integrated Water Resources Management in the Lower Jordan Rift Valley. 'IWRM is a participatory planning and implementation process, based on sound science, which brings together stakeholders to determine how to meet society's longterm needs for water and coastal resources while maintaining essential ecological services and economic benefits.' (USAID: [link](#))". The left sidebar contains a search box, a 'general knowledge' section with links to 'Knowledge browser', 'IWRM-Analysis', and 'SMART project', a 'navigation' section with links to 'Main page', 'Recent changes', and 'Help', and a 'toolbox' section with links to 'What links here', 'Related changes', 'Upload file', 'Special pages', 'Printable version', 'Permanent link', and 'Browse properties'. The main content area features three images: 'Water System Knowledge Browser' (circled in red with the annotation **3.**), 'IWRM-Analysis', and 'SMART - Innovative technologies and concepts'. At the bottom, a 'Need help?' section provides links to a 'Help site' and a 'Dropedia mailing list - dropedia@lists.kit.edu - (subscribe)'.

Dropedia – The Water System Knowledge Browser

Water resources characterisation

Knowledgebase for the Water Resource System in the Lower Jordan River Basin

1.

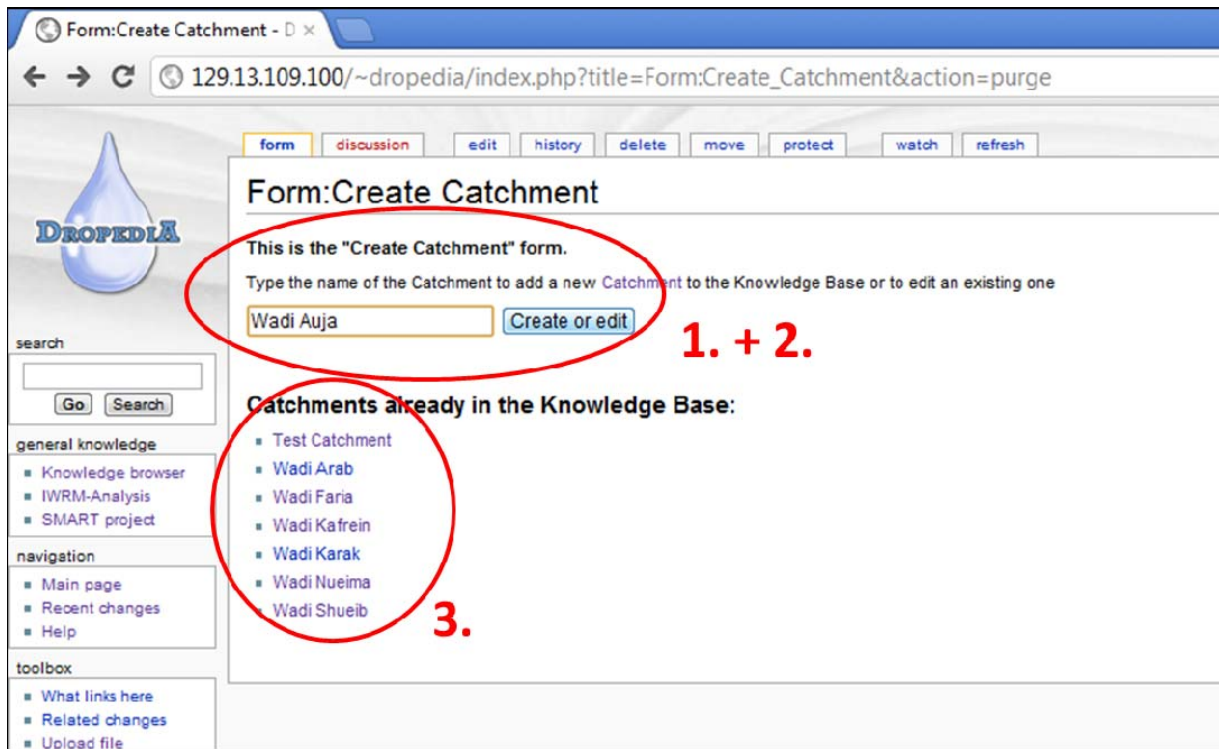
2.

Catchment	Country	Governorate/District
Wadi Arab	Jordan	Irbid
Wadi Katrein	Jordan	Al Balqa Governorate
Wadi Shueib	Jordan	Al Balqa Governorate
Wadi Nueima	Palestine	Ramallah Governorate
Wadi Faria	Palestine	Nablius Governorate
		Jericho Governorate
		Tubas Governorate

- 1. The knowledge browser shows the basic structure behind the Dropedia and lists all elements that are already available.
- 2. A good start is always to create your study area if it does not exist yet in the list. To do so click on “[Add Catchment](#)” (you can also use this if your study area is not exactly a catchment!)

Dropedia – Create a catchment/study area

1. When creating a new element in Dropedia you will always find the “[Create ...](#)”-Forms for every element-type (catchments, springs, municipalities, WWTPs, ...)
2. Enter the name of the element and click the [create button](#)! The autocomplete in the field will show elements that are already available.
3. If you would like to edit an already existing catchment (or element) just follow the link to its page.



Form:Create Catchment - D x

129.13.109.100/~dropedia/index.php?title=Form:Create_Catchment&action=purge

form discussion edit history delete move protect watch refresh

Form:Create Catchment

This is the "Create Catchment" form.

Type the name of the Catchment to add a new [Catchment](#) to the Knowledge Base or to edit an existing one

Wadi Auja [Create or edit](#) **1. + 2.**

Catchments already in the Knowledge Base:

- Test Catchment
- Wadi Arab
- Wadi Faria
- Wadi Kafrein
- Wadi Karak
- Wadi Nueima
- Wadi Shueib **3.**

search

Go Search

general knowledge

- Knowledge browser
- IWRM-Analysis
- SMART project

navigation

- Main page
- Recent changes
- Help

toolbox

- What links here
- Related changes
- Upload file

Dropedia – The empty Catchment-object

1. A newly created catchment (or other element) will show you an empty template-page which can now be filled with information. Therefore it provides several “[Add/edit...](#)”-links that will lead to information entry forms for the different sections of the page.
2. A good start is always the topmost link to edit the geography and meta-information.

The screenshot displays the 'Wadi Auja' Catchment page in the Dropedia interface. The page is structured into several sections, with red circles and arrows highlighting key elements:

- Section 2:** A red circle highlights the 'Add/edit Catchment Metadata' link in the 'Contents' sidebar, with an arrow pointing to the 'Geography' section header.
- Section 1:** A red circle highlights the 'Attached Files' section, with an arrow pointing to the 'General Description' section header.
- General Description:** A red circle highlights the 'Add/edit the Overview Text' link.
- References:** A red circle highlights the 'Add/edit Literature References' link.

The page also features a 'Map' section on the right, a 'Category: Catchment' sidebar, and a 'Meteorological Stations in Wadi Auja' section at the bottom.

Dropedia – The Form entry

1. Every “**Add/edit ...**”-link will lead to a form that provides fields for the section: some for text entry other to upload a file or to choose a location on a map.
2. To apply your changes you need to click on the “**Save page**”-button (you can also have a preview beforehand).

129.13.109.100/~dropedia/index.php/Special:FormEdit/Catchment2/Wadi_Auja

special page

Add/edit geography and meta-infos and upload files: Wadi Auja

General Info

Geography

Name: Wadi Auja, Wadi Uja
(Multiple entries separated by ",")

ID-Code: ?? System:

Super-Catchment: Lower Jordan River Basin

Region: Jericho Governorate

Country: Palestine

Area [km²]: 264 km²

Kml-File:

Author: David Riepi

Major Contribution:

Map

Enter Geographic Coordinates manually or pick from map below:
31.967868° N, 35.358975° E

Wadi Uja

POWERED BY Google

2 mi
2 km

Map data ©2012 Mapas G/Srael - Terms of Use

New Palestine Grid Coordinates:

Files

General Info

☐ This is a minor edit ☐ Watch this page

Dropedia – Upload a file

1. Every “**Upload**”-link will lead to a popup-form that lets you browse your computer and upload all kinds of files (you normally never have to fill all fields in a form, unless it sometimes says so!).
2. In this example I will upload a kmz-file (google-earth-polyline) of the Wadi Auja catchment

The screenshot shows the Dropedia website interface. The main page is titled 'Add/edit geography article' and contains a form for adding or editing a geography article. The form has several sections: 'General Info', 'Geography', and 'Meta information'. The 'Geography' section is currently active, showing fields for Name, ID-Code, (Super-)Catchment, Region, Country, Area (km²), Kmz-File, Author, Major Contribution, and a checkbox for 'This is a minor edit'. The 'Meta information' section includes fields for File Type*, Caption, Keywords, File Description, and Reference. A popup form titled 'Datei hochladen' (Upload file) is open in the foreground, showing the upload process. The popup form has a header 'Datei hochladen' and a sub-header 'Dateien hochladen und auf dieser Seite verlinken:'. It shows the user 'User:DavyDisco' and a section 'Erlaubte Formate' (Allowed formats). The 'Upload' section contains fields for 'Source filename' (with a 'Datei auswählen' button), 'Destination filename', and a checkbox for 'Ignore any warnings'. The 'Meta information' section in the popup form includes fields for 'File Type*', 'Caption', 'Keywords', 'File Description', and 'Reference', each with a brief instruction in parentheses.

Dropedia

special page

Add/edit geography article

General Info

Geography

Name: Wadi Auja, Wadi Uja
(Multiple entries separated by commas)

ID-Code: ??
e.g. AM0512

(Super-)Catchment: Lower Jordan River E

Region: Jericho Governorate

Country: Palestine

Area (km²): 264 km²

Kmz-File: Wadi Auja Catchment
Upload file

Author: David Riepl

Major Contribution:

☐ This is a minor edit ☐ Watch this page

Save page Show preview Show preview

Meta information

File Type*:
(The type of the uploaded file: Choose: Chart, Data File, Document, Image, Map, Multimedia or Misc File)

Caption:
(Short description of the file, preferably one sentence)

Keywords:
(Here you can tag the file with different keywords)

File Description:
(Here you can enter a description of this file)

Reference:
(Reference of this file)

Upload file

Dropedia – Add more Information

1. After saving a form – you immediately see your changes on the page. Don't worry if you made some mistakes, every change is recorded, can be undone and recovered again for an unlimited time.
2. Next you can start to enter some more information about the catchment. Just have a look at the provided sections and see where you would like to contribute.

The screenshot shows the 'Wadi Auja - Dropedia' web application. The browser address bar shows the URL '129.13.109.100/~dropedia/index.php/Wadi_Auja'. The page has a navigation bar with links like 'page', 'discussion', 'edit', 'history', 'delete', 'move', 'protect', 'watch', and 'refresh'. The main content area is titled 'Wadi Auja' and 'Catchment'. It features a 'Contents' sidebar on the left with links to various sections like '1 Catchment', '2 Attached Files', '3 General', etc. The main content area is divided into sections: 'Add/edit Catchment Metadata', 'Geography', 'Authors', and 'Map'. The 'Geography' section contains a table with fields like 'Name(s)', 'ID-Code', '(Super-)Catchment', 'Region(s)', 'Country', and 'Area (km²)'. The 'Map' section shows a map of the Wadi Auja catchment area with a red boundary. The 'Attached Files' section shows a file named 'File:Wadi Auja Catchment boundary.kmz'. The 'General Description' section is partially visible at the bottom.

Wadi Auja - Dropedia

129.13.109.100/~dropedia/index.php/Wadi_Auja

Wadi Auja

Catchment

Contents [hide]

- 1 Catchment
- 2 Attached Files
- 3 General
- 4 Catchment Description
- 5 Catchment Land Use
- 6 Catchment Water Resources
- 7 Catchment Water Demand Sites
- 8 Catchment Water Supply Network
- 9 Catchment Sanitation Network
- 10 Catchment Water Balance
- 11 Catchment Water Management
- 12 Other Information

Add/edit Catchment Metadata

Geography	
Name(s)	Wadi Auja, Wadi Uja
ID-Code ()	??
(Super-)Catchment	Lower Jordan River Basin
Region(s)	Jericho Governorate
Country	Palestine
Area (km²)	264 km²

Authors	
Author(s)	David Ricipl
Major Contribution	

Map

Geographic Coordinates: 31° 58' 4" N, 35° 21' 32" E

NPG Coordinates

Attached Files

Attach a File

File:Wadi Auja Catchment boundary.kmz --

General Description

General Overview

Dropedia – Add more Information

1. For example I will add some general text-Information and create a literature-reference for the Wadi Auja catchment.
2. By the way: Literature References are stored as extra pages, that you can create. So you can of course add the same reference to different elements (autocompletion will help you here).

special page

add/edit general description of object: Wadi Auja

General Catchment Description

General Overview

Wadi Auja (also: el-Auja, Uja) is a subbasin of the Lower Jordan River Basin located ten kilometers north of Jericho.

1.

References

Multiple entries here are delimited by ";*!!"

2.

Create new Reference

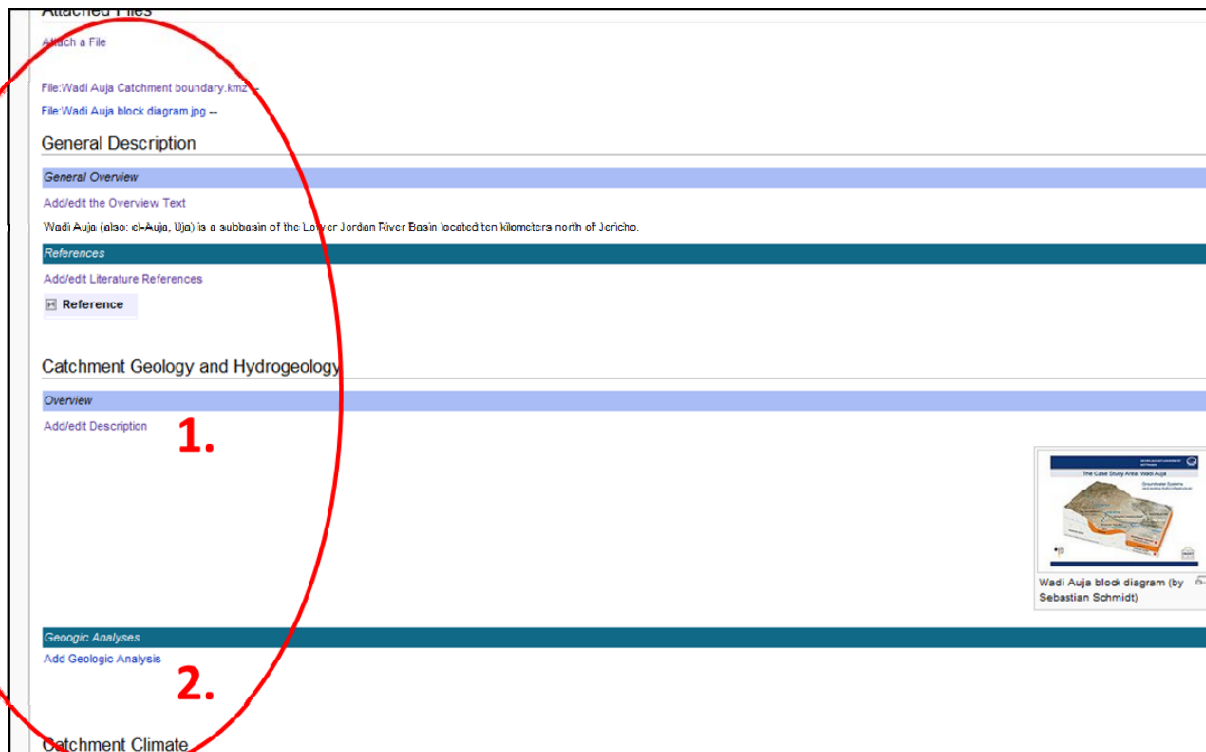
Summary:

☐ This is a minor edit ☐ Watch this page

[Save page](#) [Show preview](#) [Show changes](#) [Cancel](#)

Dropedia – Page sections

1. Every element that you create has a set of sections that roughly organize its information (e.g. Water Resources, Water Supply Network, Water Demand Sites, etc.).
2. And most sections have **two subsections**:
 1. **Overview: Place for free textual information.**
 2. **Analysis: These are an important structural element in Dropedia: Always if you want to create some special piece of information about your work, you will create an Analysis (an extra page), which is linked to an object in Dropedia! In an Analysis you can freely define properties and discuss aspects of your work. An example follows later on.**



Attached Files

Attach a File

File: Wadi Auja Catchment boundary.kmz

File: Wadi Auja block diagram.jpg

General Description

General Overview

Add/edit the Overview Text

Wadi Auja (also: el-Auja, Uja) is a subbasin of the Lower Jordan River Basin located ten kilometers north of Jericho.

References

Add/edit Literature References

Reference

Catchment Geology and Hydrogeology

Overview

Add/edit Description **1.**

Geologic Analysis

Add Geologic Analysis **2.**

Catchment Climate



Dropedia – Add further elements

1. After creating the Wadi Auja catchment, I want to add further elements to the catchment, for example the Auja Spring.
2. This will actually result in a very similar workflow as the catchment creation. I can “[Add a Spring](#)” from within the Catchment-page or also from the Knowledge-Browser. Or just by browsing to the [Form:Create Spring](#). The same of course applies for all other elements

The screenshot shows the web application interface for Wadi Auja. The browser address bar displays '13.109.100/~dropedia/index.php/Wadi_Auja'. The main content area is organized into several sections:

- Catchment Land Use**: Includes 'Land Use Overview' and 'Add/edit Land Use description'.
- Catchment Water Resources**: This section is highlighted with a red circle and the number '2.'. It contains 'Water Resources Overview', 'Add/edit Water Resources description', and 'Catchment Water Resources Analyses'. The right-hand side of this section, titled 'Water Resources in Wadi Auja', lists 'Add Stream - [Add Spring](#) - Add Reservoir - Add Well'. The 'Add Spring' link is circled in red, and a button labeled 'Form:Create Spring' is visible below it.
- Catchment Water Demand Sites**: Includes 'Water Demand Overview', 'Add/edit Water Demand description', and 'Catchment Water Demand Analyses'.
- Catchment Water Supply Network**: Includes 'Water Supply Overview', 'Add/edit Water Supply description', and 'Catchment Water Supply Analyses'.

The interface uses a blue and white color scheme with a sidebar on the right.

Dropedia – Add further elements

1. It also looks quite similar. Just the structure of the content is of course somewhat different!
2. For the Auja spring I now want to add some more sophisticated information on its discharge properties. Thus I decide to create an Analysis in the Water Discharge-section by clicking on “[Add Water Discharge Analysis](#)”

The screenshot displays two overlapping browser windows from the Dropedia application. The background window is the 'Form:Create Spring' page, which includes a search bar, a list of 'Springs already in the Knowl...', and a sidebar with navigation links. The foreground window shows the 'Auja Spring' page, which contains a table of metadata, a map, and sections for 'Discharge-Timeseries' and 'Attached Files'. A red arrow points from the 'Springs already in the Knowl...' list on the left to the 'Auja Spring' page.

Form:Create Spring

This is the "Create Spring" form.
Type the name of the Spring to add a new Spring

Springs already in the Knowl...

To edit one of these please do so on their

- Abu Saleh Spring
- AlDlaib Spring
- AlFarah Spring
- AlSubyan Spring
- Azraq Fuheis Spring
- Baqqouria Spring
- Hazzir Spring
- Jeser Spring
- NewSpring
- Qdairah Spring
- Shorea Spring
- TestSpring

Auja Spring

Spring

Geography	
Name	Auja Spring, Uja Spring
ID/Code ()	
Catchment	Wadi Auja
Region	Jericho Governorate
Country	Palestine
Altitude [m] asl	
Aquifer	
Spring type	
Water type (salinity)	
Discharges to	
Monitoring Station(s)	

Authors

Author(s)

Discharge-Timeseries

This section shows the available datasets in the SMART-database at UFZ Leipzig (DAISY Database Browser)

loading

loading

Attached Files

Attach a File

Files (0/1000) -

General Description

General Overview

Add the Overview Text

Dropedia – Add Analysis

1. As mentioned before, Analyses are stored as separate pages. This helps a lot in organizing different views, scenario assumptions and spatial and temporal scales!
2. An Analysis in this respect can actually be everything from a simple interpolation work up to a complete abstract of your thesis or project report.
3. So by “Add Analysis” we will get a new form that lets us exactly describe what we are working on and actually you are very free on how to describe it. However some important information is the **Location field** that should link to the object of your Analysis (in this case the Auja Spring).



[knowledge](#)
[edge browser](#)
[-Analysis](#)
[T project](#)
[n](#)
[page](#)
[it changes](#)
[links here](#)
[ed changes](#)
[is file](#)
[el pages](#)
[e properties](#)

Edit Analysis: Auja Spring Discharge Measurements

Analysis Title:

Please choose a unique and meaningful name for your analysis - The dropdown shows you analysis already existing in Dropedia

Author (of this entry):

Category of the Analysis:

Reference(s):

[Create new Reference](#)

Location (spatial relation):

Subject of the Analysis:

Related IWRM Model:

Time Period of the Analysis:

Description:

[[File:Auja Springs Discharge Measurements.jpg|400px]]

Attached Files

[Upload file](#)

[Remove](#)

[Add another](#)

Properties

please use this area to define the most important properties of the Analysis (e.g. the parameters that are finally used in the model)!

Property:	Value:	Unit:	Scenario:	Confidence:	Officially approved:	Comment:
Mean Discharge	9.7	MCM/a	Status Quo	high	☐	for mean water year condition
(name the parameter, e.g. "population" or "average annual discharge" ...)	(number or string)	(e.g. % per year)	(default is "Status Quo")	(evaluate the (un)certainty of the parameter value)	(is the value approved by the official Decision Maker institutions?)	(anything else)
Remove						

Property:	Value:	Unit:	Scenario:	Confidence:	Officially approved:	Comment:

Dropedia – Add Analysis-Properties

1. A specialty of the Analysis-pages is the possibility to “**add properties**”. With properties you can describe the important and central figures of your Analysis (normally results). To do so just click on “**Add another**” under the properties section.
2. Then you can define the property-name (e.g. Mean Discharge) and its value and some important additional information like your expert estimate of confidence in the outcome etc.

The screenshot shows the 'Properties' section of the Dropedia interface. It contains a table with three rows of properties, each with fields for Property, Value, Unit, Scenario, Confidence, Officially approved, and Comment. A red circle labeled '2.' highlights the entire table. Below the table is a 'Comments' section with a text area and a 'Remove' button. A red circle labeled '1.' highlights the 'Add another' button located between the table and the comments section.

Property:	Value:	Unit:	Scenario:	Confidence:	Officially approved:	Comment:
Mean Discharge (name the parameter, e.g. "population" or "average annual discharge" ...)	9.7	MCM/a (number or string) (e.g. % per year)	Status Quo (default is "Status Quo")	high (evaluate the (un)certainty of the parameter value)	☐ (is the value approved by the official Decision Maker institutions?)	for mean water year conditions (anything else)
Minimum Discharge (name the parameter, e.g. "population" or "average annual discharge" ...)	0.7	MCM/a (number or string) (e.g. % per year)	Status Quo (default is "Status Quo")	high (evaluate the (un)certainty of the parameter value)	☐ (is the value approved by the official Decision Maker institutions?)	for dry water year conditions (anything else)
Maximum Discharge (name the parameter, e.g. "population" or "average annual discharge" ...)	18.0	MCM/a (number or string) (e.g. % per year)	Status Quo (default is "Status Quo")	high (evaluate the (un)certainty of the parameter value)	☐ (is the value approved by the official Decision Maker institutions?)	for wet water year conditions (anything else)

Comments
please enter your comment on the Analysis subject

Author: David Riepl

Comment:
I created this page as an example. Please edit it, if you have more and better information.

